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20.2: Experimental Demonstration of MBK2, an Eight-Beam, Five-Cavity Multiple-Beam Klystron

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Abstract: *We describe the results of recent experiments with an eight-beam, five-cavity multiple-beam klystron (MBK).*

Keywords: Vacuum electronics, klystron, multiple-beam.

Introduction

The NRL eight-beam, five-cavity multiple-beam klystron, shown in Fig. 1, is the second in a series of *S*-band MBKs developed at the Naval Research Laboratory and was designed to produce a peak output power of 600 kW with a 3-dB instantaneous bandwidth of ~6%. The eight-beam electron gun is of the same design as used in our previous MBK and operates at a nominal cathode voltage of 45 kV and a total current of 32 A [1,2].

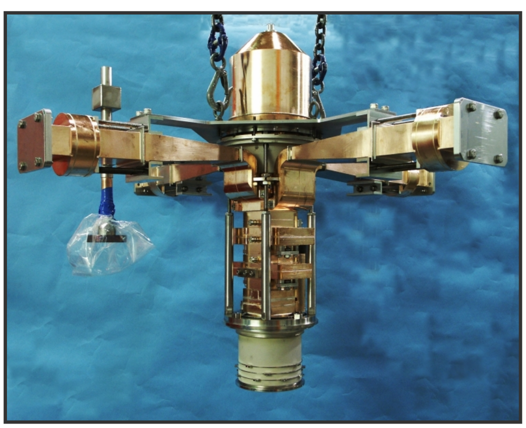


Figure 1: MBK2 – Eight-beam, five-cavity MBK.

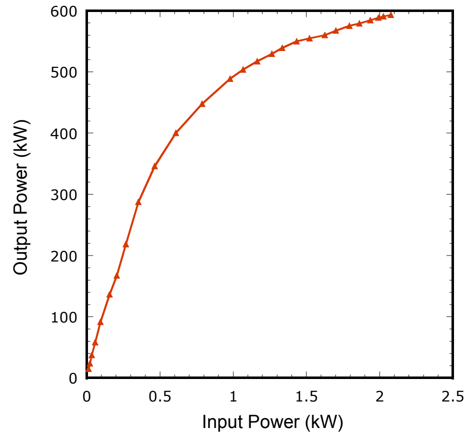
The electrodynamic circuit is comprised of a two-gap input cavity, a two-gap idler cavity, two additional single-gap idler cavities, and a two-gap output cavity and has a total length of 22 cm [3]. All of the multi-gap cavities operate in the π-mode. Some of the cavities were loaded with a lossy dielectric to reduce the Q. Output power is extracted from both of the output resonator gaps in four waveguide arms (two on each gap). The desired and measured cavity frequencies and Q's are summarized in Table I.

Cavity	*f* (GHz)		*Q*	
	Design	**Meas.**	**Design**	**Meas.**
Input (2-gap)	3.156	3.148	54	75
Idler 1 (2-gap)	3.328	3.309	65	74
Idler 2	3.384	3.365	63	51
Idler 3	3.456	3.458	~5000	>5000
Output (2-gap)	3.213	3.200	19	22

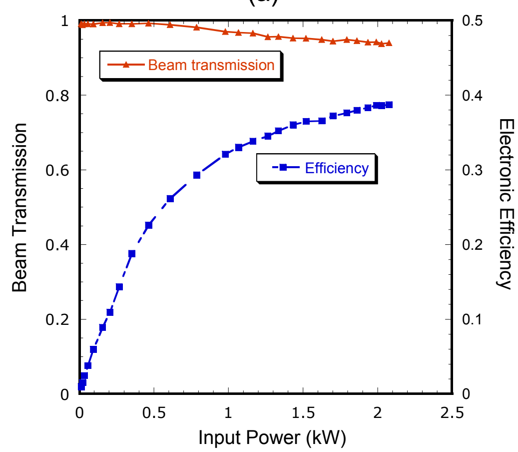
Table I: MBK2 Circuit Parameters.

Experimental Results

Figure 2 plots the MBK2 response as a function of input power driven at a single frequency. The tube produces ~600 kW of peak output power at saturation with a corresponding electronic efficiency of 40%. Beam transmission is excellent: >99% in the small-signal regime and >93% at saturation.



(a)



(b)

Figure 2: (a) Measured MBK2 output power, and (b) beam transmission and electronic efficiency, versus input power (f = 3.15 GHz).

Figure 3 plots the measured output power as a function of frequency with the input power kept constant. A mismatch in the input circuit reduces the gain in the upper portion of the band and is responsible for the uneven response. Despite the mismatch, however, the circuit has a measured 3-dB bandwidth of ~6% and produces >300 kW over the band. Efforts are currently underway to improve the input circuit match.

To conclude, we will discuss the design versus experimental performance of the tube and present the results of numerical modeling with the MAGIC 3D particle-in-cell code [4] and the 2.5D large-signal code, TESLA [5].

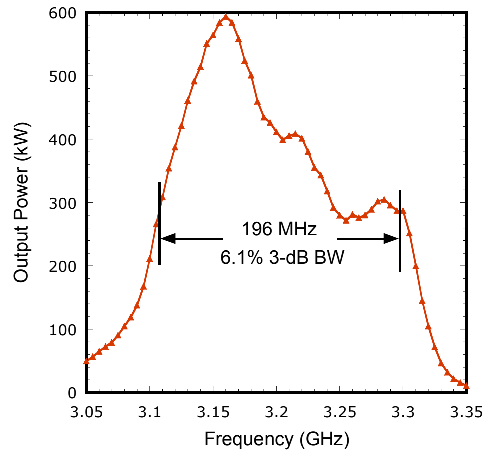


Figure 3: Measured output power versus frequency at a constant drive power.

Acknowledgement

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